

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/38005

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G01B 9/02

US CL : 356/450, 491-495, 487, 489

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 356/450, 491-495, 487, 489

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,950,103 A (SCHMIDT-WEINMAR) 13 April 1976 (13.04.1976), Figure 17.	1-34

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Y		13-17
Y,P		13-17
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Abstract

PUBLICATIONS

Three channel phase-shifting interferometer using polarization-optics and a diffraction grating

Andrea Hettwer, Jochen Kranz, Johannes Schwider

Publication: *Optical Engineering* 39(04), p. 960-966, Roger A. Lessard; Ed.

Publication Date: Apr 2000

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Abstract

A modified Michelson interferometer is described by which three, by $-\pi/2$, 0 and $+\pi/2$ phase-shifted interferograms can be taken simultaneously by a single CCD camera using a binary diffraction grating and polarization optics. Hence measurements of dynamic events and in adverse conditions are possible. The experimental setup, first results and a mathematical error analysis are presented. (Copyright)2000 Society of Photo-Optical Instrumentation Engineers.

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Suezou Nakadate

Univ. of Rochester and Tokyo Institute of Polytechnics (Japan)

Masaki Isshiki

Tokyo Institute of Polytechnics (Japan)

Two real-time phase mapping methods for fringe patterns are presented, which are based on a spatial phase-shifting with three fringe patterns, and on a spatial synchronous detection for a tilted fringe pattern. A digital TV-image processor is implemented which bases on the two fringe processing techniques. Applications of the present methods to surface shape measurements using a polarization interferometer and a fringe projection technique, and to a surface deformation measurement using a holographic interferometer are described. Worst phase errors are analyzed theoretically which are caused by an additive intensity noise of input fringe signals and a multiplicative intensity noise due to misalignments of a measuring system. A phase error due to a digitization of calculations is also evaluated numerically.

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Affiliation: AA(Univ. of Rochester and Tokyo Institute of Polytechnics) AB(Tokyo Institute of Polytechnics)

Publication: Proc. SPIE Vol. 2544, p. 74-86, Interferometry VII: Techniques and Analysis, Malgorzata Kujawinska; Ryszard J. Pryputniewicz; Mitsuo Takeda; Eds. ([SPIE Homepage](#))

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Two real-time phase mapping methods for fringe patterns are presented, which are based on a spatial phase-shifting with three fringe patterns, and on a spatial synchronous detection for a tilted fringe pattern. A digital TV-image processor is implemented which bases on the two fringe processing techniques. Applications of the present methods to surface shape measurements using a polarization interferometer and a fringe projection technique, and to a surface deformation measurement using a holographic interferometer are described. Worst phase errors are analyzed theoretically which are caused by an additive intensity noise of input fringe signals and a multiplicative intensity noise due to misalignments of a measuring system. A phase error due to a digitization of calculations is also evaluated numerically.

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Large surface profile measurement with instantaneous phase-shifting interferometry

N. R. Sivakumar, W. K. Hui, K. Venkatakrishnan, and B. K. A. Ngoi

Nanyang Technological University, Precision Engineering and Nanotechnology Centre, School of Mechanical and Production Engineering, Nanyang Avenue, Singapore 639798

(Received Mar. 13, 2002; revised Jul. 9, 2002; accepted Jul. 15, 2002)

Surface profile measurement of smooth surfaces is a vital area in many of today's industries, especially in wafer fabrication. The increased need for high-speed, noncontact online measurement with high accuracy and repeatability is of great interest for practical purposes. In this work, a modification of Michelson interferometers in combination with instantaneous phase-shifting interferometry is proposed for high-speed large flat-surface profiling. Experiments are carried out on a patterned wafer surface. The results obtained using this system are compared with a commercial profiler system to demonstrate the validity of the principle. ©2003 Society of Photo-Optical Instrumentation Engineers.

doi:10.1117/1.1532331

PACS: 06.30.Bp, 07.60.Ly, 85.40.Qx

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Chris L. Koliopoulos

Phase Shift Technology, Inc. (USA)

Interferometric testing of large optics over long path lengths has been hampered by vibration in the test set-up. The precision of phase measuring interferometry has not been able to provide measurements in vibration environments due to the time required to perform the required phase shift between multiple images of the interferogram. The simultaneous phase shift interferometer (SPSI) has eliminated effects of vibration from phase measurements by creating four separate phase shifted interferograms simultaneously, viewed with four CCD cameras. The CCD cameras provide electronic shutter exposure control which effectively 'freezes' the interference patterns producing high contrast interferograms even with severe vibration. Polarization optics are used to maintain the appropriate phase relationships between the four interferograms. Four separate synchronized video digitizers are used to digitize the interferograms to a maximum resolution of 380 by 240 pixels by 8 bits per pixel. The phase at each pixel in the interferogram is calculated by a PC/486 based microcomputer which also provides complete analysis and graphics of the measurement. Averaging of multiple measurements to reduce the effects of air turbulence is done automatically.

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